CAUTION: This product should be used only under the supervision of a licensed medical practitioner.

INSTRUCTIONS
OLYMPIC
SMART SCALE®
Model 50

220/240 VAC, 50/60 Hz, 10 W

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OLYMPIC MEDICAL
5900 First Ave So • Seattle, WA 98108 • USA

For information or assistance
Call Toll-Free 1 800 426-0353

Section One

Summary Operating Instructions — OLYMPIC SMART SCALE™

Model 50

To Adjust Platform

- One or both ends may be lowered depending on size of child.

To Lower Ends(s)

- While holding end, press red button and then lower end.

To raise end(s)

- Lift end as high as possible and until red button pops out and the word LATCHED appears on the top of the button.

To Turn On

- Push On/Off button. Wait until zero weight appears on display.

To Weigh Child

- Place child on platform. Note: Sides and ends are part of weighing platform.
- If child is active, press Average/Unlock button. Wait for Averaging light to stop blinking and Locked light to come on. Read weight.
- Do not touch platform while Averaging light is blinking.

To Reweigh Child

- Press Average/Unlock button to unlock display.
- Press Average/Unlock again. Wait for Averaging light to stop blinking and Locked light to come on. Read weight.

To Recall Weight

- If Scale is turned off, press Recall to display last locked in weight.

To Weigh Next Child

- If locked, press Average/Unlock button to unlock display.
- Place child on platform.
- Press Average/Unlock button. Wait for Averaging light to stop blinking and Locked light to come on. Read weight.

To Cancel Out Weight of Toys, Blankets or Other Objects

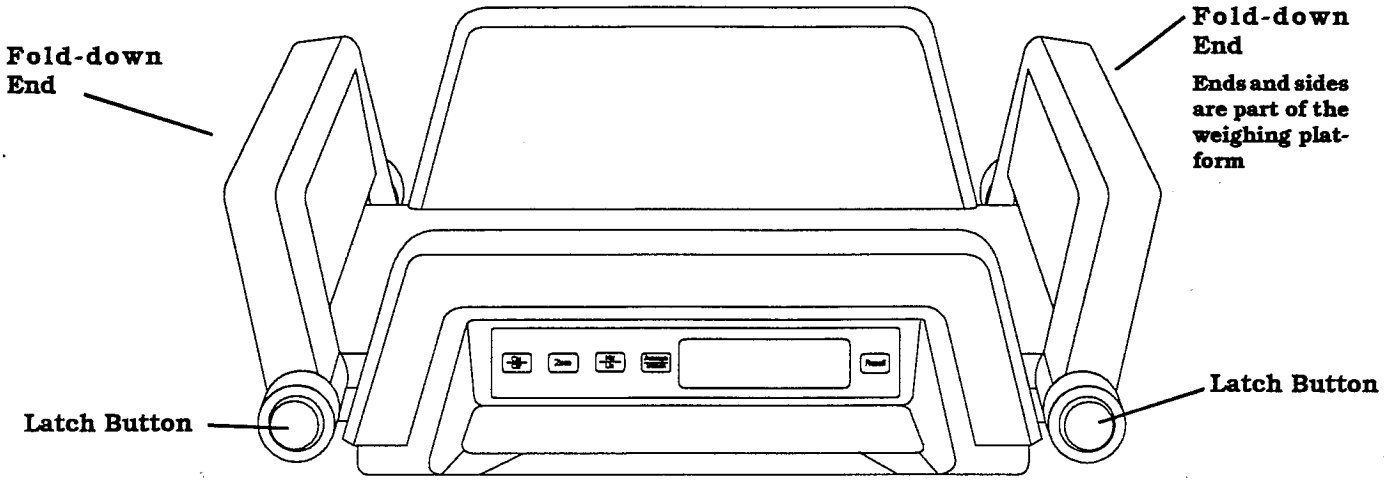
- If Scale is off, place object on platform. Turn Scale on and wait for zero weight to appear. Then place child on platform and proceed with weighing.
- If Scale is turned on, place object on platform and press Zero button After zero weight appears in display, place child on platform and proceed with weighing.

To Change Kilograms to Pounds-Ounces and Vice Versa

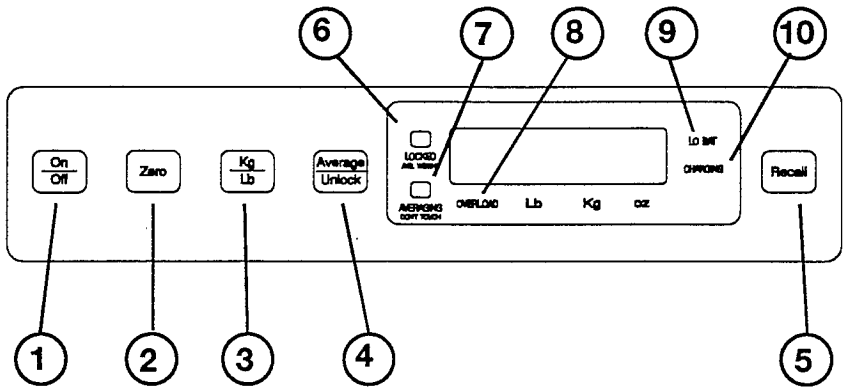
- Press Kg/Lb button.

For Information
Please call toll-free
1 800 426-0353

Controls and Signals



Control Panel



Controls

1. **On/Off** Turns Scale on or off. (If operating on batteries, Scale turns off automatically 3 minutes after weighing.)
2. **Zero** Press to cancel out (tare out) weight of any objects on the platform before placing child on platform.
3. **Kg/Lb** Press to convert pounds-ounces to kilograms and vice versa.
4. **Average/Unlock** Press to get a four-second average of a moving child's weight. The weight will lock into the display. Press again to unlock display.
5. **Recall** Press to display the last locked weight.

   NOTE: Recall only operates when the Scale is turned off.

Status Lights

6. **Locked (Green)** Child's average weight is locked on display. Displayed weight value will not change, even if child is removed from Scale.
7. **Averaging (Yellow)** Scale is computing a four-second average of child's weight. Do not touch child while Averaging light is flashing or weighing error will result.
8. **Overload Signal** Will come on when weight on platform exceeds 55 lbs (25 Kg).
9. **Lo Bat Signal** Will come on when approximately one-half hour of battery life remains.
10. **Charging** Comes on when batteries are charging (whenever Scale is connected to wall outlet).

Operation—AC or Battery

The following instructions apply whether Smart Scale is operating connected to a wall outlet or operating on its rechargeable batteries.

NOTE: The Scale can be used for weighing while the batteries are recharging or even if the batteries have been removed.

To Turn On/Off

Press the On/Off button on the front panel. Wait until a series of walking dashes go across the display. When the zero weight reading appears, the Scale has automatically found its zero reference point. The Scale is adjusted at the factory to power-up in the Pounds-Ounces mode. See page 4-2 to change power-up mode to kilograms.

Note: Weight of blankets or any other objects placed on the platform before the zero reading appears will be automatically cancelled.

Adjusting Platform Ends

Hold the platform end and press the large red button (Fig. 2-2) to release the platform ends. Lower the end.

To return an end to the full-up position, lift the end until it locks into place. The word LATCHED will appear in the button's rim (Fig. 2-3).

Either one or both ends can be lowered to accommodate the child being weighed. Whenever possible, both ends should remain up to safely hold the child.

CAUTION: Ends should only be placed in the full-down or full-up position. Ends lock only in the full-up position when LATCHED appears on the red button rim.

CAUTION: Do not allow child to sit or stand on the ends.

Weighing Child

After zero weight appears, place child in platform.

Child Not Moving

If the child is not moving, read and record the "live" weight displayed.

Child Moving

If the display is changing too rapidly to get an accurate "live" weight, press the Average/Unlock button. The yellow Averaging light starts blinking while the Smart Scale takes a four-second average of the child's weight. At the end of the averaging cycle, the green Locked light will come on. Read and record the displayed weight.

CAUTION: Touching the platform or child while the Averaging light is blinking can result in an incorrect weight. If that happens during weighing, see below.

Weight Lock/Unlock

Weight remains on display until Average/Unlock button is pressed to unlock the display. If the Scale is turned off while the display is locked, it will re-zero itself when the Scale is turned back on.

Note: Make sure zero weight is not accidentally locked into the display. When display shows zero weight, the green Read light must be off. If the Read light is on, press Average/Unlock.

If scale is touched during averaging:

1. Wait for the Locked light to come on.
2. Press Average/Unlock to unlock the display.
3. Press Average/Unlock again.

Recalling Last Locked Weight

If Smart Scale is turned off or loses power, the last locked in weight can still be recalled by pressing Recall button.

With power off, press Recall button. Scale display will come on and display the last locked weight for 10 seconds then turn off.

Note: Recall button works only when power is off.

To Weigh Next Child

If the display is locked (green Read light is on), press Average/Unlock button. Scale reads zero. If not, press Zero button.

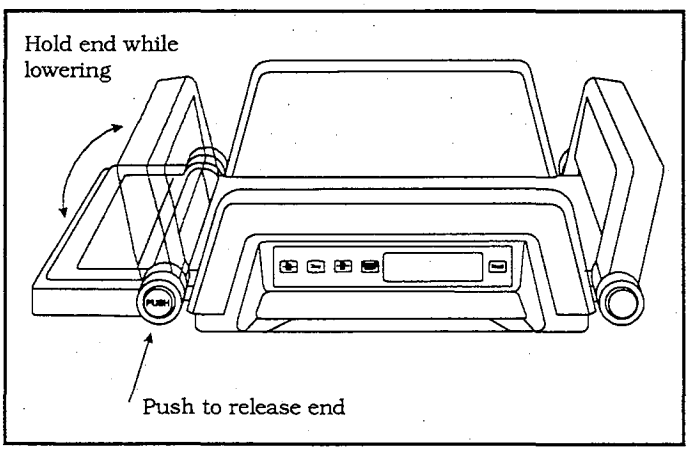


Fig. 2-2 Lowering Scale Sides

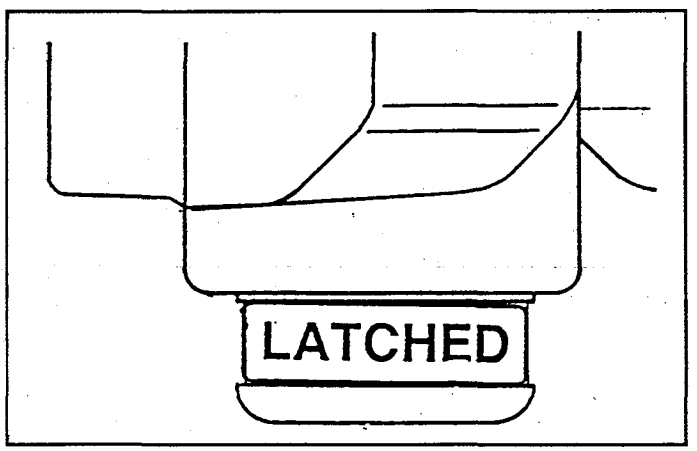


Fig. 2-3 Latch Button Rim

Pounds-Ounces to Kilograms

When first turned on the Scale reads in pounds-ounces, down to one ounce. To display weight in kilograms (kg) press the Kg/Lb button. Kilograms are displayed to 0.02 kg. To return the display to Pounds-Ounces, press the button again.

Display Resolution

Internally, the Scale is measuring weight to the nearest 2.5 grams. In the kilogram mode, it is rounding the displayed weight to the nearest 20 grams. In the pounds-ounces mode, the weight is rounded to the nearest 28 grams before it is displayed in pounds-ounces. A manual conversion from the pounds-ounces display to kilograms may not match the Scales's kilogram display reading. This is due only to display resolution. The kilogram weight display is correct.

Cancelling Weight of Objects on Platform

There are two ways to cancel (tare out) the weight of blankets or other objects:

- **Scale on** Place blanket on platform and press Zero button. Weight of blanket will be cancelled out and display will read zero.
- **Scale off** Place blanket on platform prior to turning on. Press On/Off, when zero appears, blanket's weight has been automatically cancelled out.

Note: If blanket is removed from platform after its weight has been cancelled out, the Scale will display negative weight. Press Zero again to re-zero the Scale.

Overload

If the load exceeds 55 pounds (25 kg), the Overload signal on the display will come on. Reduce the weight on the Scale platform.

Cleaning

Smart Scale can be wiped clean with a cloth dampened with an common hospital disinfectant.

Note: Do not spill any liquid on the Scale as it might enter the case and damage the electronics.

Battery Operation

When using the Scale on batteries, wrap the power cord around the cord cleats on the back (Fig. 2-4).

Charging

The Smart Scale has internal rechargeable batteries which are automatically charged (Charging Signal comes on) whenever the Scale is connected to a wall outlet. Approximately 14 to 16 hours are required to fully charge batteries. Batteries can be continuously charged without damage.

The Scale can be used while the batteries are charging.

Charge Life

When fully charged, the Scale will operate for approximately three hours of continuous use or 50 weighings.

Low Battery

When approximately one-half hour of battery life remains, the Lo Bat signal will come on. Connect the Scale to wall outlet as soon as convenient.

If Lo Bat signal begins blinking, it indicates the battery charge has been depleted. The Scale will shut itself off automatically. It should be connected to a wall outlet for recharging or use.

Battery Replacement

See Service Section

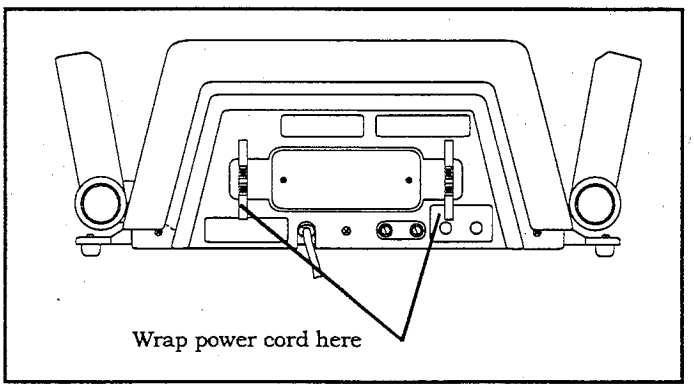


Fig. 2-4 Cord Cleats

Smart Scale is shipped fully assembled.

Display Protective Cover

Prior to first use, remove and discard the green protective cover over the display.

Stationary Use

Place Scale on flat, level table or counter surface. Make sure that Scale cannot slide or "walk" off the edge. Weight of Scale is approximately 57 pounds.

Portable Use

If the Scale is to be used on a cart, it is recommended that it be bolted to the cart using the four 10-32 UNF threaded mounting holes in the bottom of the Scale (Fig. 3-1)

CAUTION: Make sure that cart, with Scale mounted, is stable and will not tip over with added weight of patient (up to 55 pounds).

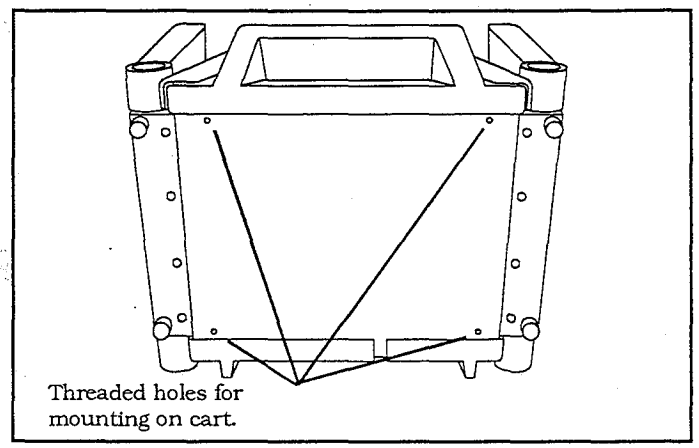


Fig. 3-1 Cart Mounting Holes

When inserted through bottom of shelf, mounting screws must project no more that 1" above top of shelf. Otherwise, they will damage the load cell when they are inserted into the Scale.

Electrical Requirements

220/240 VAC, 50/60 Hz, 0.06 Amperes

CAUTION: Use hospital-grade outlet only. Do not use adapters or extension cords.

Initial Battery Charge

Smart Scale has internal rechargeable batteries which will be automatically charged when the Scale is connect to a wall outlet.

The initial battery charge requires 14 to 16 hours to reach full charge. The Scale can be used while batteries are charging.

Carrying Scale

To pick up the Scale, grasp firmly at the bottom. Never attempt to lift Scale by sides. Two people should lift Scale as it weighs approximately 57 pounds.

Calibration Check

Every Smart Scale is calibrated at the Olympic Medical factory before shipment. However, calibration of the Scale should be checked before it is put into use. (See "Calibration" under Service Section of this manual.)

Replacing Batteries

1. Disconnect Smart Scale from wall outlet.
2. Ensure Scale is turned off.
3. The battery cover is located at the back of the Scale.
4. Loosen the two screws holding the cover in place (Fig. 4-1).
5. Remove the cover.
6. Remove the batteries and replace with six, size C, rechargeable Ni-Cad batteries. Replace all six batteries at the same time. Observe battery polarity.
7. Replace the battery cover and install the two screws holding it in place.

Replacing Fuses

Fuses are located on the back side of Scale (Fig. 3-1).

There are two fuses:

1. For AC power: 1/8 amp, 250 V, fast acting.
2. For batteries: 1 amp, 250 V, fast acting.

Replace as required.

Calibration

Rationale

As with any precision electronic instrument, the Smart Scale can drift out of calibration over time. Since no electronic scale recalibrates itself automatically, the only way to assure correct recalibration is to place an accurate, known weight on the scale and make the required internal adjustments so that the scale displays the correct weight.

Calibration Weights

The Model 50 calibration procedure requires two precision weights, Cat. No. 56357. Together the two weights weigh 12.5 kg.

Calibration Upon Receipt

The Scale was calibrated at our factory in Seattle prior to shipment. However, it should be recalibrated before being put into use because local variations in the force of gravity can affect weight by as much as 20 grams.

Calibration Frequency

Scale calibration should be checked every month for the first year. Then the frequency can be adjusted based on how far the Scale readings have drifted. If it is staying within 20-40 grams, reduce the calibration frequency to every 12 months. For larger drifts, increase the frequency to every 3 months. If the drift is very large, check the Troubleshooting section.

To begin, place the Scale on a firm, level surface. Ambient temperature should be between 70° and 75°F, normal room temperature.

Calibration Switch Access

The calibration switch access panel is located on the front panel under the controls (Fig. 4-2).

1. Remove the two screws holding the cover in place to expose the calibration switches.
2. Push Calib switch, S1-2 (Fig. 4-3), up.

Procedure

Turn the Scale on. The display should read "SCALE CALIb." If not, make sure the calib switch is up.

1. Turn the Scale on. Exercise the load cells by placing the two calibration weights in the center of the platform for 10 seconds. Then remove the weight for ten seconds. Repeat three times.
2. Place the 12.5 kg calibration weights in the center of the platform.
3. Adjust the Coarse Zero pot (Fig. 4-3) until the display reads 16,384 ±30.

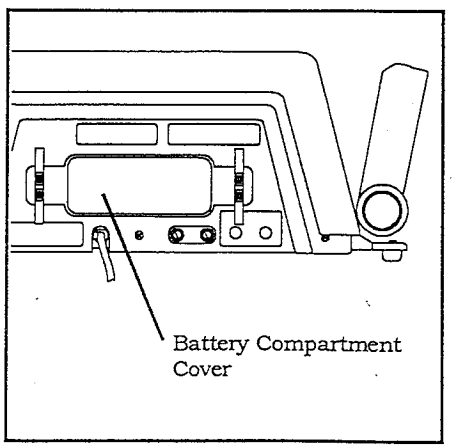


Fig. 4-1 Battery Cover (on back of Scale)

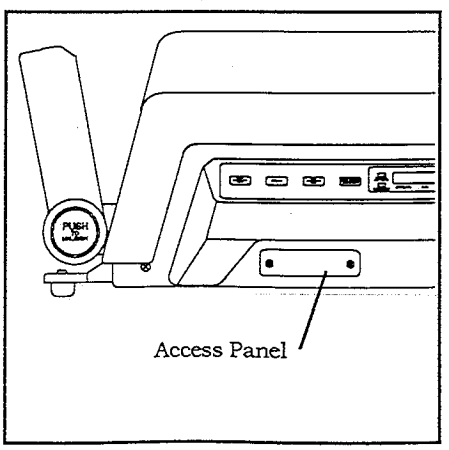


Fig. 4-2 Calibration Switch Access Panel

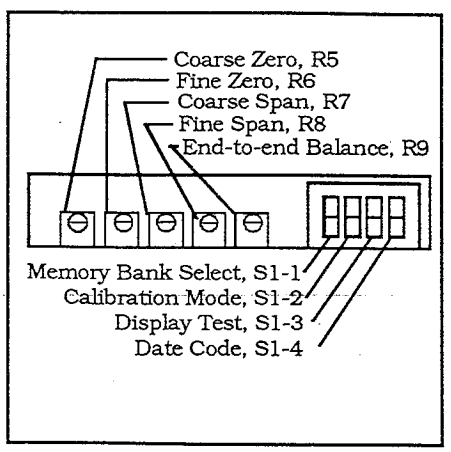


Fig. 4-3 Calibration Switches

4. Adjust the Fine Zero pot until the display reads 16,384.

Note: Due to electronic noise, the display will jitter ±2. This is normal.

5. Momentarily press Zero button. The display will read 0 ±2.

6. Remove the calibration weights.

7. Adjust the Coarse Span pot (Fig. 4-3) until the display reads -5000 ±30.

8. Adjust the Fine Span pot (Fig. 4-3) until the display reads -5000 ±2.

9. Press Zero. The display should show 11,384. If not, repeat steps 2 thru 8. If the Scale will not calibrate, contact the Olympic Medical Service Department toll free number 1 800 426-0353.

10. Press Calib switch off, (Fig. 4-2), down.

11. Replace Calibration hatch cover.

Changing Power-Up Display

Smart Scale is pre-set to power up in the pounds-ounces mode. To have it power up in the kilograms mode:

1. Disconnect the power cord from the wall outlet.

2. Remove the two screws holding the calibration switch panel (Fig. 4-2).

3. Push switch S1-1 down.

4. Replace access cover.

Specifications

Accuracy (Nominal): ± 0.02 kg (1oz)

Capacity: 25 kg (55 lb)

Resolution: 0.02 kg (1 oz)

Scale Weight: 57 lb.

Scale Dimensions:

Sides Up: 28"W x 22"D x 10"H

Sides Down: 38.3"W x 22"d x 10"H

Power Requirements:

220/240 VAC, 50/60 Hz, 10 W

Battery Requirements:

Six, C-size, NiCad, rechargeable

Troubleshooting

The Olympic Smart Scale, Model 50, can be field serviced to the printed circuit board (PCB) level. The faulty board must be returned to Olympic Medical for repair or replacement.

In order to identify the problem, please follow the Troubleshooting and Theory of Operation sections carefully.

Troubleshooting requires the weighing platform be removed to expose the test points on the scale's main printed circuit board (Fig. 4-7).

Prior to performing any troubleshooting, read the Smart Scale Theory of Operation, page 4-7. This provides an overview of how the Scale circuits operate

CAUTION: Only hospital-qualified personnel should perform internal servicing. Electrical shock hazard when circuits are exposed.

Static and Contamination

The integrated circuits and semiconductors on the PCB's can be damaged by electrostatic discharge or by body oil contamination and fluids such as disinfectants. Always observe proper handling precautions (below) at all times.

- Minimize handling of circuit boards.
- Discharge personal static by touching grounded metal or by wearing a grounded wrist strap, before touching parts.
- Keep replacement boards in their anti-static bags until ready to use.
- Avoid touching pins or traces. Handle PCBs by edges to avoid static discharge and avoid contamination by oil from fingers.
- Avoid plastic, vinyl and styrofoam in the work area.
- Avoid wearing clothing which may pick up static electricity.
- Do not slide PCBs or components over any surface.

Troubleshooting Hints

CAUTION: Operate Scale in the battery mode, when possible, to avoid electric shock.

- Analyze symptoms BEFORE disassembly and troubleshooting. Read the Theory of Operation section to understand the system. Formulate a theory of a possible cause for the symptom and make tests to check the theory.
- Check the easiest and most obvious possible problems first (such as fuses, mechanical interference, dead batteries, etc.).
- Study the specifications and user's instructions, particularly the front panel switch logic to be sure that the Scale is behaving abnormally. In some situations certain switches normally do not work. For example, Zero will not work if display is locked. Recall will only work if the Scale is off.
- Perform a thorough visual inspection. All connectors and cables should be connected and secure. Check for chafed or pinched wires. Check for signs of overheated components. Check that all socketed parts are firmly seated in their sockets. Check for interference with load

cell movement such as wires or mechanical binding.

- Take measurements with respect to signal ground, TP10. Troubleshoot the Scale using the test points on the Main Board. The test points are in numerical order from left to right on the front of the Main Board. Their function is summarized in the table, Fig. 4-10.
- Operate Scale both on batteries and AC to see if symptom is the same.

Dissasembly

1. Turn off the Scale and unplug from the wall outlet.

2. Slide one end of the Scale so it overhangs the table (Fig. 4-4).

3. Unscrew the four socket head cap screws through the holes in the chassis (Fig. 4-5). Repeat for the other end.

4. Lift the platform assembly up to expose the weighing platform (Fig. 4-6).

Note: The platform assembly, with its hinged ends, is not field repairable and should not be disassembled. If it is damaged it should be returned to Olympic Medical for repair or replacement.

The Main Board test points are now exposed (Fig. 4-7).

Removing Weighing Platform

It is not necessary to remove the weighing platform unless the main printed circuit board must be removed.

1. Remove the two socket head cap screws and the two flat head cap screws (Fig. 4-8).

2. Lift the weighing platform off. Take care not to lose the spacer (Fig. 4-9).

Removing Main Board

1. Disconnect all connectors: Transformer, Load Cells, Battery and Display Board.

2. Remove the mounting screws holding the board in place.

3. To replace the board reverse the above steps.

Reassembly

Reassemble the Smart Scale by reversing the dissassembly steps.

When installing weighing platform, the two socket head cap screws (Fig. 4-8) require 90 in-lb torque. The two flat head cap screws need only to be tight.

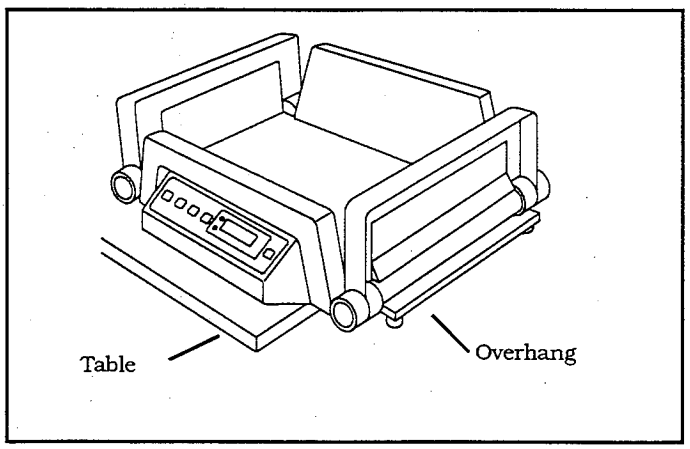


Fig. 4-4 Scale Disassembly

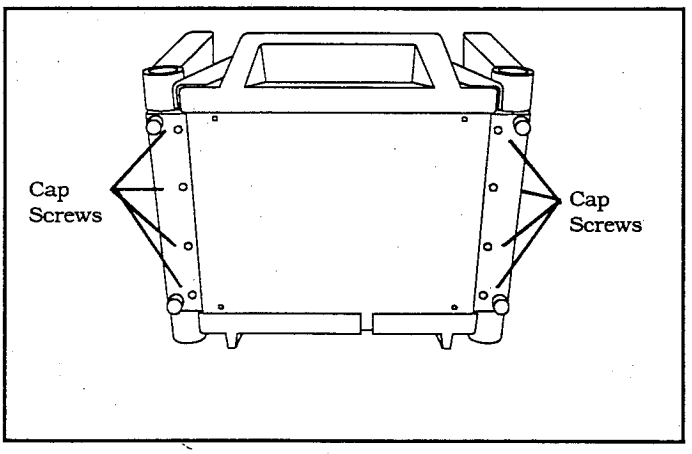


Fig. 4-5 Cap Screws

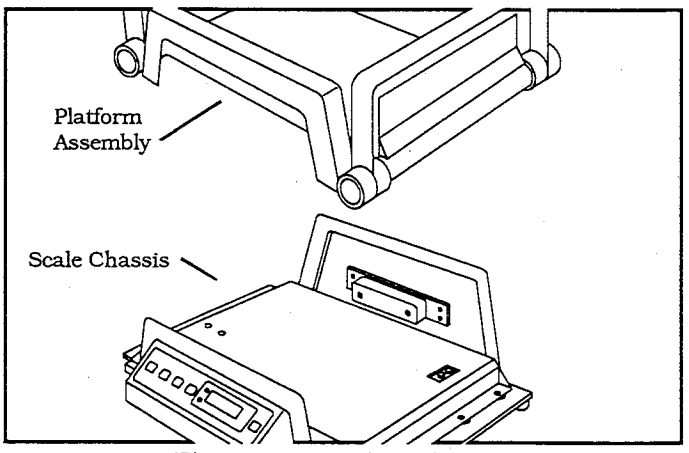


Fig. 4-6 Removing Platform

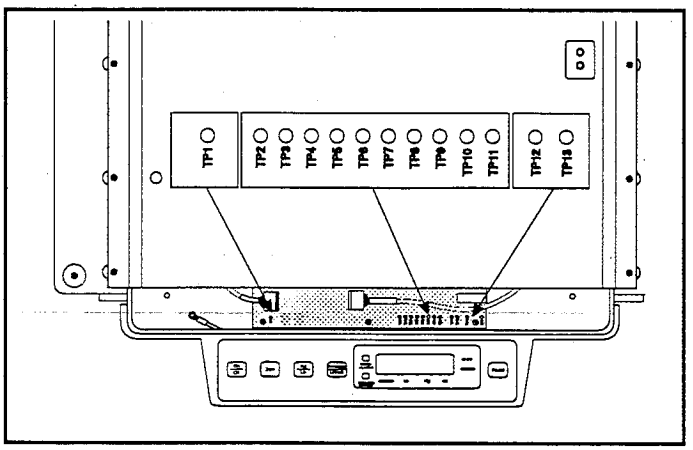


Fig. 4-7 Test Points On Main Board

The cap screws attaching the main platform to the chassis (Fig. 4-5) require 4-6 in-lb torque.

Note: When reinstalling the weighing platform, ensure the channel connected to the right load cell is square and the swing arms move freely.

CAUTION: The Smart Scale must be recalibrated whenever is has been disassembled and reassembled. See page 4-1

Symptoms and Suggested Tests

For Test Point voltage values, refer to the Test Point Chart in Fig.4-10.

Scale will not come on and zero:

1. If walking dashes are displayed, there are two possible causes:

a. The signal is beyond the zero capture range. This could be caused by a bad load cell or a power problem. Remove the main platform assembly (in disassembly procedure) so the aluminum platform is exposed. This will also expose the front edge of the Main Board with its test points (Fig. 4-10).

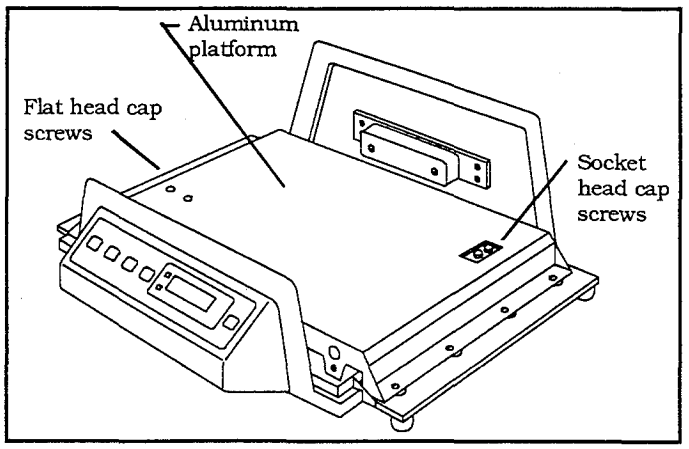


Fig. 4-8 Weighing Platform Cap Screws

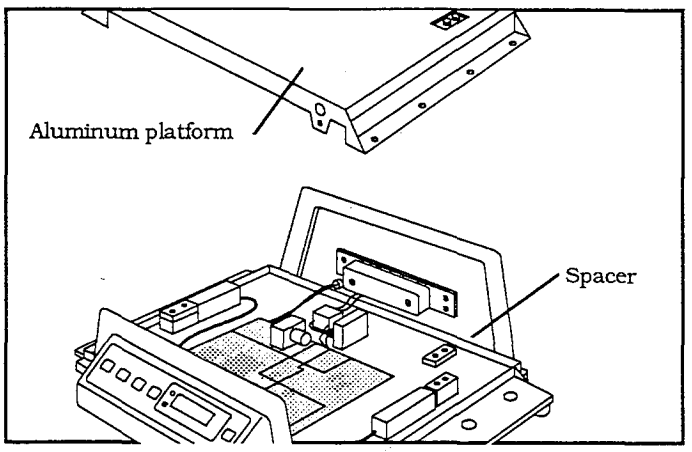


Fig. 4-9 Weighing Platform Spacer

- Check power voltages at test points TP3, TP5 and TP11 (with respect to ground, TP10).
- Check that the zero offset voltage is correct at TP1. Typical value with the main platform assembly removed will be around -1.2 volts.
- Check that the signal at TP2 is correct. Typical value with the main platform assembly removed will be about -1.1 volts but the A/D should be able to capture anything between -2.00 volts and +2.00 volts.
- Check that the A/D reference voltage at TP6 is correct—around 1.00 volts.

b. The signal is too unstable to acquire zero. This could also be caused by a power problem.

Check the +5Va and the -5Va at test points with a scope and verify that there is no excessive noise on these lines. If voltages are correct, check noise on the signal at TP2.

Test Point	Description
TP1	Zero offset. -1.2 volts with platform ass'y. off
TP2	Analog signal input from amps to filter & A/D
TP3	+5 Va Analog +5 volts for load cells, amps, A/D
TP4	Chopper clock
TP5	-5 Va Analog -5 volts for amps & A/D
TP6	A/D ref voltage. 1.00 volts normal
TP7	Vin (Battery voltage) or +11.25 Vdc if on AC.
TP8	Not very low battery signal
TP9	Not low battery signal
TP10	Ground
TP11	+5 Vd Digital +5 volts for µC, displays, etc.
TP12	Not On/Off switch signal input
TP13	Not Recall switch signal input

Fig. 4-10 Test Point Voltages

2. **If the walking dashes do not appear, and the On/Off switch is ineffective:** Listen for the reed relay clicking (to turn on the DC power). If clicking cannot be heard then check the fuses on the back. One fuse is for batteries and the other is for AC.

If the relay clicks, then the appropriate fuse is functioning. Then check to determine that the Scale stays on. This can best be verified by observing the LED, DS1, on the right front of the Main Board (Fig. 4-11).

The main platform assembly must be removed. DS1 indicates that +5Vd is present.

If DS1 does not come on (even momentarily) then check connectors from the membrane panel to the Display Card to the Main Board.

Pressing the On/Off switch should make TP12 on the Main Board go low. If there is no voltage of any kind at TP12 then check that connector P1 from the transformer is connected to J1 on back of the Main Board.

Also verify that connector P2 is connected to J2 when on batteries. The aluminum sub-platform must be removed to inspect these connectors. Also verify voltage at TP7. Try on both AC and batteries.

If DS1 comes on but no walking dashes appear, it indicates that the µC is not working. Verify that the jumpers near the µC (U12) are correct. JP2 should have a jumper at A and JP3 should have one at B. Also verify that the EPROM, U13, is properly seated in its socket. The I/O expander, U15, is also suspect at this point.

If the On/Off switch signal is at TP12 and DS1 lights but does not remain lit when On/Off is released, check relay K1. The µC, EPROM, I/O expander and jumpers are suspect again (previous paragraph).

If DS1 won't illuminate, verify voltage at TP7. It should be about +11.25 V if on AC and 6 to 8 volts if on batteries.

If proper voltage is present at TP7 and a low (below 0.5V) voltage reading comes in on TP12 when On/Off switch is activated, but DS1 still won't come on, then the On/Off latching circuit is bad and the Main Board must be replaced.

If the voltage is not at TP7, check the AC input through F1, filter FL1 to primary of T1. T1 secondary voltage coming into J1 (pins 1 and 3) should be about 19.9 Vac (with Scale off; no load). Voltage across the large electrolytic capacitor, C43 should be about 26 Vdc (no load).

Scale will not lock:

Pressing Lock/Unlock should provide a low to pin 16 of U15 on the Main Board. If not, check membrane switch on front panel and connectors down to the Main Board. If pin 16 of U15 is receiving the signal but the Lock/Unlock function is still inoperative, replace the Main Board.

Scale will not change units:

Pressing the Kg/Lb switch should provide a low to pin 23 of U15 on Main Board. If not, check membrane switch on front panel and connectors on the Display Card down to the Main Board. If pin 23 of U15 is receiving the signal, replace Main Board.

Scale will not zero with Zero button:

Pressing Zero should provide a low on pin 1 of U15 on Main Board. If not, check membrane switch and connectors on the Display Card to the Main Board. If signal is OK, but Scale still shows no response to the Zero button, replace Main Board.

Recall switch will not turn on the Scale:

Pressing Recall should provide a low at TP13. If it does not, then check the connectors from the membrane front panel to the connectors on the Display Card and to the Main Board.

If a low is seen at TP13 when the Recall switch is activated, but the Scale will still not turn on and show last locked weight for 10 seconds, then the On/off latch circuit is suspect. Replace Main Board.

Recall switch activates the display but the Scale shows the incorrect weight (e.g. 0.00 Kg):

Check that the non-volatile ram, U16, is plugged in. U16 has a small internal battery which may go dead after many years. Olympic Medical guarantees the battery for 10 years.

Some segments or annunciator lights do not come on:

Turn on the Scale with the On/Off switch while holding either the Lock/Unlock, Zero or Kg/Lb switch. This turns on all segments and lights. If all LEDs do not light, either replace the Display Card or purchase new displays from Olympic Medical. Replace all six whenever one fails. This will ensure digits have the same brightness.

Scale will not weigh accurately:

The load cells are suspect. Slight linearity errors (exceeding specifications) or off-center load errors can be caused by a defective load cell. However, other factors could cause errors. Check that nothing (cables, etc.) is touching or rubbing on platform. All weight must go through the load cells. Also check that the ends are not binding on the right load cell.

If the percent error is constant throughout the range, recalibrate. If errors are random or there is a linearity problem, calibration will not work.

Check power supply voltages. If voltages are correct, weighing inaccuracy or drift can be caused by a defective load cell or the analog circuitry on the Main Board. The load cell connectors are also suspect. Return Scale to Olympic Medical for analysis.

Scale drifts:

Drift can be caused by moisture, contamination, a bad connection or a bad load cell. Return the Scale to Olympic Medical for repair.

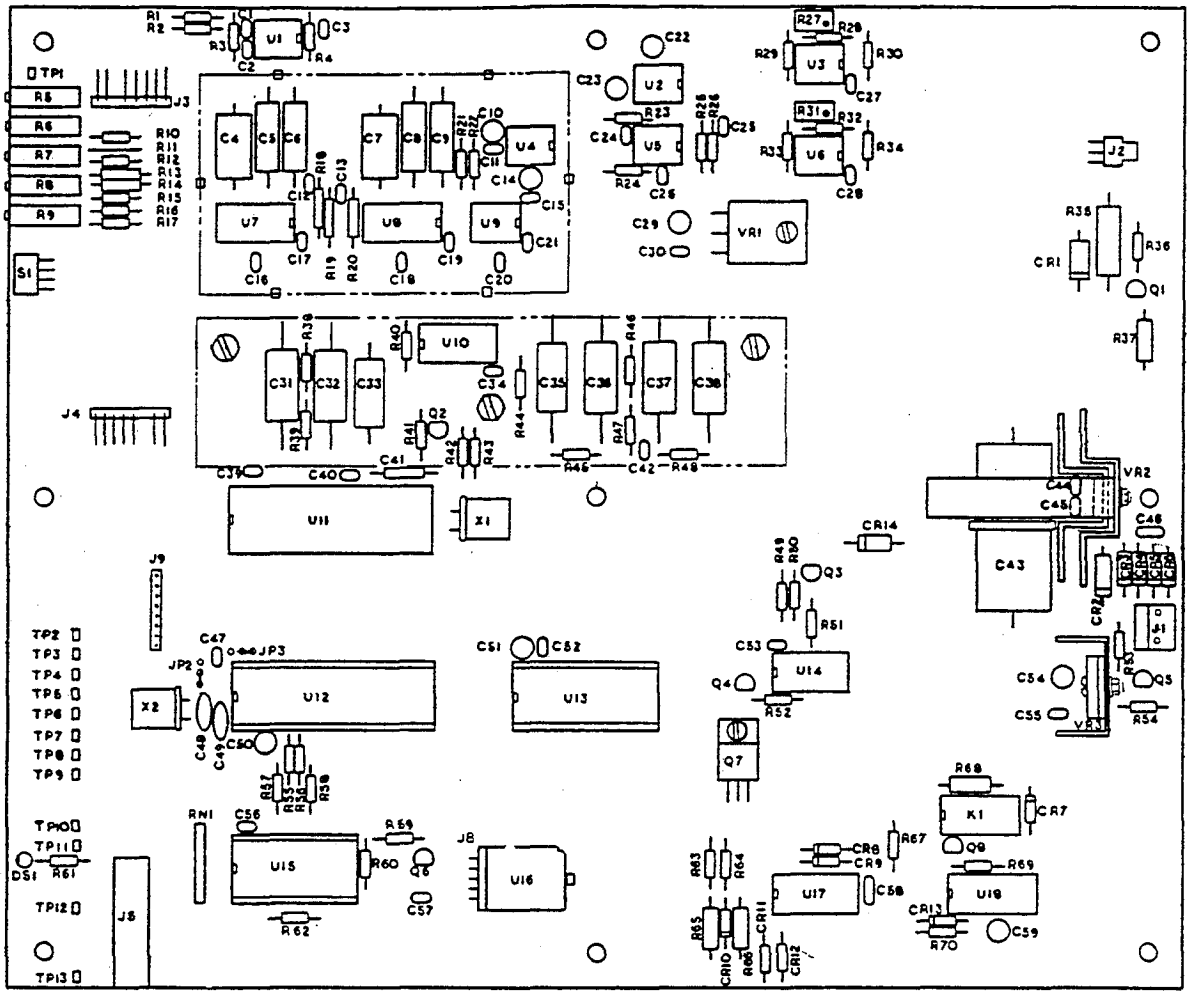


Fig. 4-11 Main Board Assembly

Theory of Operation

General Overview

Fig. 4-12 is a simplified block diagram tht illustrates the essential components of an electronic scale. A weight sensing device translates a force into an electrical signal. This analog signal is amplified and translated into a digital signal for a microcomputer (µC). The µC takes this raw weight data (usually binary) and performs manipulations to present it in readable form on a display.

Load cells are used as the weight sensing devices in the Olympic Pediatric Scale. A load cell contains four strain gauges connected to form a Wheatstone Bridge (Fig. 4-13).

If an excitation voltage is applied in two opposite corners of the bridge, a small differential signal occurs at the other two corners. This signal will be proportional to the applied weight. The signal is also proportional to the excitation voltage.

The Pediatric Scale employs "ratiometric" operation. If a small change in excitation voltage occurs causing a signal change, the gain and zero circuits change in the opposite direction to counteract the original change.

Pediatric Scale Overview

Refer to the block diagram in Fig. 4-14. The Scale has two printed circuit boards: the Main Board and the Display Card. Components are mounted on the chassis. The front panel has five membrane switches.

Power Supply

Line power is connected through a fuse and RFI filter to the primary of the power transformer. The secondary AC is rectified and filtered on the Main Board. The DC is regulated by a +12 V regulator which provides all current to the Scale.

The +12 V from the regulator supplies the charging circuit for the nickel-cadmium batteries. It also provides a signal indicating to the computer that alternating current (AC) is present. The +12 Volts are also applied to the on/off latch circuit. The On/Off membrane switch on the front panel controls the on/off latching circuit.

Each time the On/Off switch is activated, this circuit alternately turns a reed relay on and off which controls DC power to the Scale. The Recall switch can also turn the Scale on but it cannot turn the latch off.

The power supply has a +5 V regulator for digital power and another +5 V regulator for analog power. A switching regulator provides negative voltage to an op-amp which provides -5 V analog voltage which tracks the +5 V analog voltage. Separate digital and analog grounds are used.

Signal Flow

Refer to the Block Diagram, Fig. 4-14. The weight on the platform is sensed by the load cells. The signal from the load cells is amplified by a chopper stabilized instrumentation amplifier.

The zero control provides ratiometric zero offset to cancel the tray weight and load cell offset, and provide DC offset for the A/D converter. Either of two filters can be selected by the µC.

First a light filter is used because it allows rapid acquisition of the weight data. The µC switches to the heavier filter when in the Averaging mode. (The µC also performs software averaging to get the best possible approximation of the weight.)

The span (gain) control is also ratiometric and controls the gain of the A/D.

The A/D provides binary data to the µC. An external EPROM is used to store the software. An I/O expander receives inputs from the Zero, Lb/Kg and Lock/Unlock switches on the front panel. Since both the On/Off switch and the Recall switch turn on the Scale in hardware, the µC must determine which switch turned it on. Therefore, these switches are also indirectly tied to the µC. There are two serial data outputs to display drivers on the Display Card.

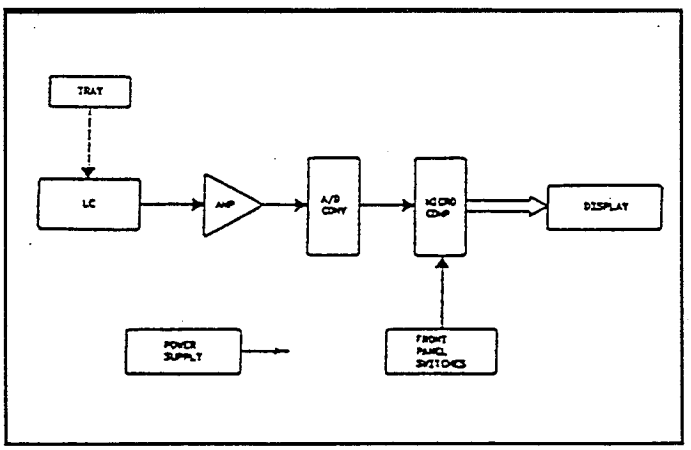


Fig. 4-12 Essential Scale Components

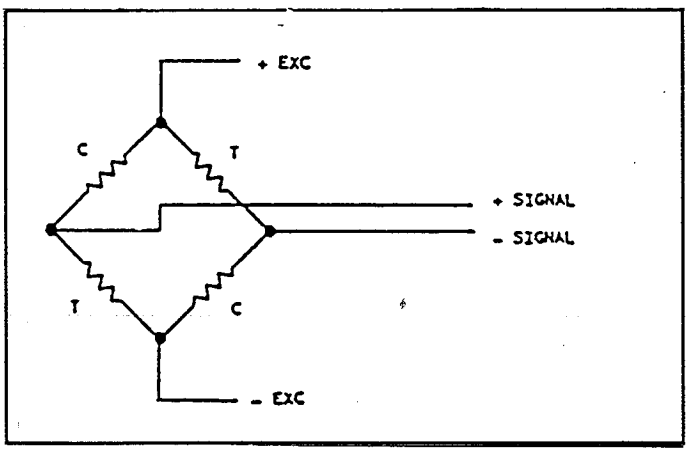


Fig. 4-13 Wheatstone Bridge

Detailed Circuit Description

Load Cells

The wiring diagram, Fig. 4-15, shows the load cell connections. Inside the load cells there are temperature compensation networks which are not shown.

The capacity of the Scale is 25 kilograms. The sensitivity of each load cell is 2mV per volt at 30 kg. The output signal of one separate load cell is 2mV per volt of excitation at 30 kg.

The load cells are connected in parallel through a balancing pot, R9. The net effect is an output of 148.5 nV per gram (with 5.0 Volts excitation). Since this is such a small signal, a very stable amplifier is needed.

Instrumentation Amplifier

Refer to the Main Board schematics, Fig. 4-16, 4-17 and 4-18.

U7 and U8 form a differential chopper stabilized instrumentation amplifier. The gain is fixed by R18, R19 and R20 at 328.3. These are special precision resistors whose temperature coefficients are matched to within 3 parts per million per degree C. The input to the amplifier is guarded at the common mode voltage of about +2.5 V provided by U9.

U4 is a high accuracy unity gain amplifier. It changes the differential input to a single ended output. It also sums in the zero offset voltage. Zero offset is provided from R5, R6 and U1. A copper electrostatic shield is situated over this very sensitive analog section. The signal from U4 output is fed through either filter to the input of the A/D converter, U11. Analog switches of U10 are used to select the appropriate filter.

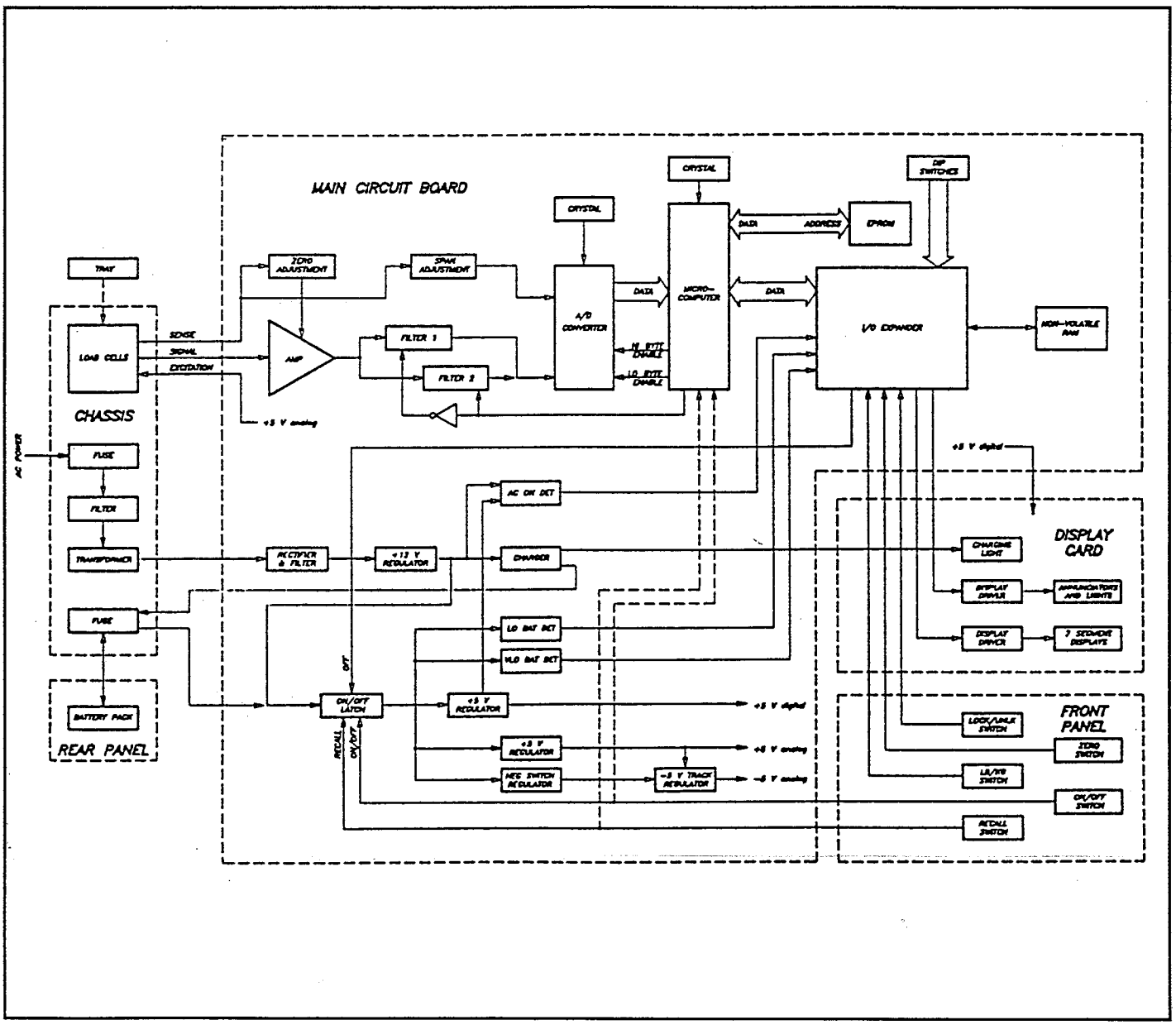


Fig. 4-14 Detailed Block Diagram

Analog to Digital Converter

Refer to the Main Board schematics, Figs. 4-16, 4-17 and 4-18.

U11, the A/D converter, is an integrating, charge balancing type. Each conversion cycle takes about 400 msec. It has a dynamic range of ± 32,768 counts (15 bits plus sign; a total of 65,536 counts). The input signal to the A/D is about 48.82 µV per gram.

The system is designed to internally resolve 1.25 grams for each count of the A/D (0.8 counts/gram).

The gain of the A/D (and the system) is controlled by R7 and R8 which provide its reference voltage. This reference voltage should be 1/2 of the A/D range of ± 32,768 counts or:

$$\frac{1}{2} \times \frac{48.82\mu V}{g} \times \frac{1.25g}{cnt} \times 32{,}768cnt = 1.000\ V \text{ (Typ at TP3)}$$

This may vary depending on the exact sensitivity of the load cells.

This is fully ratiometric. For example, if the +5 V excitation to the load cells decreases slightly, then the load cells' signal decreases proportionately for the same weight; however, the A/D reference voltage will also decrease thereby increasing the A/D's sensitivity (gain). The resultant digital output will remain the same.

To utilize the full range of the A/D, the system's zero offset is such that 12.50 kg gives a zero input voltage to the A/D. 25.00 kg will equal +0.610 volts and zero kg equals -0.610 volts. These voltages can be measured at TP2.

NOTE: The zero offset voltage at TP1 will be lower than -0.610 V because it must also cancel out the weight of the platform. Voltage at TP1 is around -1.17 volts. This may vary somewhat depending on the exact weight of the scale's platform and the particular degree of zero offset of the load cells.

The µC monitors the Data Valid line and, when valid, reads the A/D binary output. The A/D presents the high order bits or low order bits depending on the request by the µC via the High Byte or Low Byte Enable lines.

Note : All voltages given are nominal. Each system will vary depending on its specific load cell sensitivity, zero offset and tray weight.

Microcomputer

Refer to the Main Board schematic, Fig. 4-18.

The microcomputer, U12, is an 80C39, a member of the 8048 family. It has RAM inside and uses an external EPROM, U13. U15 is an input/output expander. The function of the µC is controlled by firmware (software). The software occupies 4K bytes of the EPROM.

Software overview

The computer performs housekeeping chores such as initialization to thePound-Ounce mode and auto-zero upon power up. It performs zero tracking for slow shifts less than ±10 grams.

If weight is applied, it computes weight in proper units. Also, it performs averaging and locks the best approximation of the weight on the display if requested by the Lock/Unlock button.

The last locked weight is stored in the non-volatile external RAM. This data is retrieved in the Recall mode. The non-volatile RAM has a serial interface.

The front panel switches are continually scanned. The µC interfaces to the A/D directly but otherwise interfacing is done by U15.

Data is clocked to each of the two display drivers (on the Display Card) serially with a common clock. The µC does 7 segment decoding and formatting to illuminate the correct segments and annunciators.

The quad DIP switch, S1 in Fig. 4-3, can be used to aid in trouble-shooting and calibration. S1-1 is the Memory Bank Select switch. It can select either the upper 4K or lower 4K bytes of the EPROM.

If S1-1 is up, the Scale powers up in thePounds-Ounces mode. If S1-1 is down, the Scale powers up in theKilograms mode. Otherwise, the code in both sides of the EPROM is identical.

As mentioned, the A/D has 1.25 gm/count internal resolution. However, due to noise, the A/D data is divided by 2 by the µC to give an actual internal resolution of 2.5 grams per count.

If S1-2 is turned on, the display will show these counts from 0 to 32,768. The system is biased (with the zero adjustment) so that 11,384 counts is zero weight (that will be a signal voltage of about -0.610 volts at TP2, Fig. 8). 12.50 Kg will be a reading of 16,384 counts (a signal voltage of 0 volts) and 25.00 Kg will give a reading of 21,384 counts (a signal input of +0.610 volts).

Voltages will vary depending on the specific sensitivity of individual load cells and whether the system is calibrated. In the calibration mode, the Zero button alternately zeros and unzeros the display.

If the display test switch, S1-3, is activated (prior to power-up), then a display test routine is activated which shows segments and annunciators sequentially and then turns them all on. This is convenient for verifying that no segments are open or shorted to another segment. Also, it is used to adjust the segment brightness.

If the Scale is turned on with the On/Off switch while either the Zero, Lb/Kg, or Lock/Unlock switch are also held down, then all segments and annunciators light up (regardless of what dip switches are activated) until the switches are released.

S1-4 is the date code switch. This switch causes the display to show the last software revision date in the format MM.DD.YY. Always return S1, 2, 3 and 4 to off before returning the Scale to nursery service.

Display

Refer to Display Card schematic, Fig. 4-19.

Data is clocked serially into two display drivers with a common clock. The format is one start bit followed by 35 data bits. On the 36th clock, all 35 data bits are automatically latched to the outputs of the display drivers.

Each driver has a brightness control, R1 & R2. Current of a group of lit segments can be measured at E1. High efficiency 7 segment displays are used. This allows uniform segment brightness at only 4.8 mA per segment.

If a display segment burns out, replace all six displays to retain uniform brightness. To avoid heat build-up in the power supply, never set segment current above 4.8 mA/segment.

Power Supply

Refer to Wiring Diagram, Fig. 4-15 and Main Board Schematic, Fig. 4-16.

Alternating current power from the power cord comes into the chassis. The chassis has F1, a 1/4 amp, normal-blow fuse, a filter and a transformer (F1 is 1/8 amp for 220 Vac units).

The secondary of the transformer T1 is connected to the Main Board through P1-J1. CR3 through CR6 forms a full wave bridge rectifier. CR2 is a transient voltage suppressor, and C43 and C44 provide filtering.

VR2 is a +12V voltage regulator. All Scale current comes through VR2. All these circuits are live when the Scale is plugged in, whether it is on or off.

When the Scale is off and the front panel On/Off switch (or the Recall switch) is pressed, Q7 is biased on, supplying power to U17. U17, a switch debouncer, provides some delay and toggles flip-flop, U18, on. This turns on Q8 which energizes relay K1.

When the On/Off switch is released, Q7 turns off, but now K1's contacts supply power to keep itself and everything else on.

To turn off the Scale, the On/Off switch is pressed again. Q7 turns on and a signal goes through U17 which toggles U18 off and turns off K1. The Scale is still on due to Q7, but when the On/Off switch is released, Q7 turns off and the Scale is off.

The Recall switch cannot turn the scale off. The µC can toggle U18 off (independently of the On/Off switch) by applying a low directly to pin 3 of U18. The On/Off switch (or Recall switch) must be held for at least 1/5 second for the µC to recognize it.

If the switch is hit very quickly and let go, then the µC will not know whether the On/Off switch or the Recall switch was hit, and the µC will turn the Scale off. This is normal.

The µC will turn the Scale off after 10 seconds of recall or when the very low battery threshhold is reached.

Voltage regulator, VR3, provides digital +5 volts. DS1, a small LED situated on the Main Board, shows when the Scale is on. U2, a switching regulator, provides a negative voltage. VR1 provides a regulated +5 V for the analog circuitry. The negative voltage from U2 is applied to U5 which has a gain of -1. This inverts the +5 V analog to a tracking -5 V analog voltage.

Low battery voltage and very low battery voltage is detected by U6 and U3 respectively. Threshold adjustments are set by R31 and R27 respectively.

Front Panel The front panel contains five membrane switches. Each switch, when activated, shorts the line to ground. Membrane switches have some resistance (they do not give a direct short). Several ground traces are used to keep this resistance as low as possible (Typically 30Ω to 50Ω).

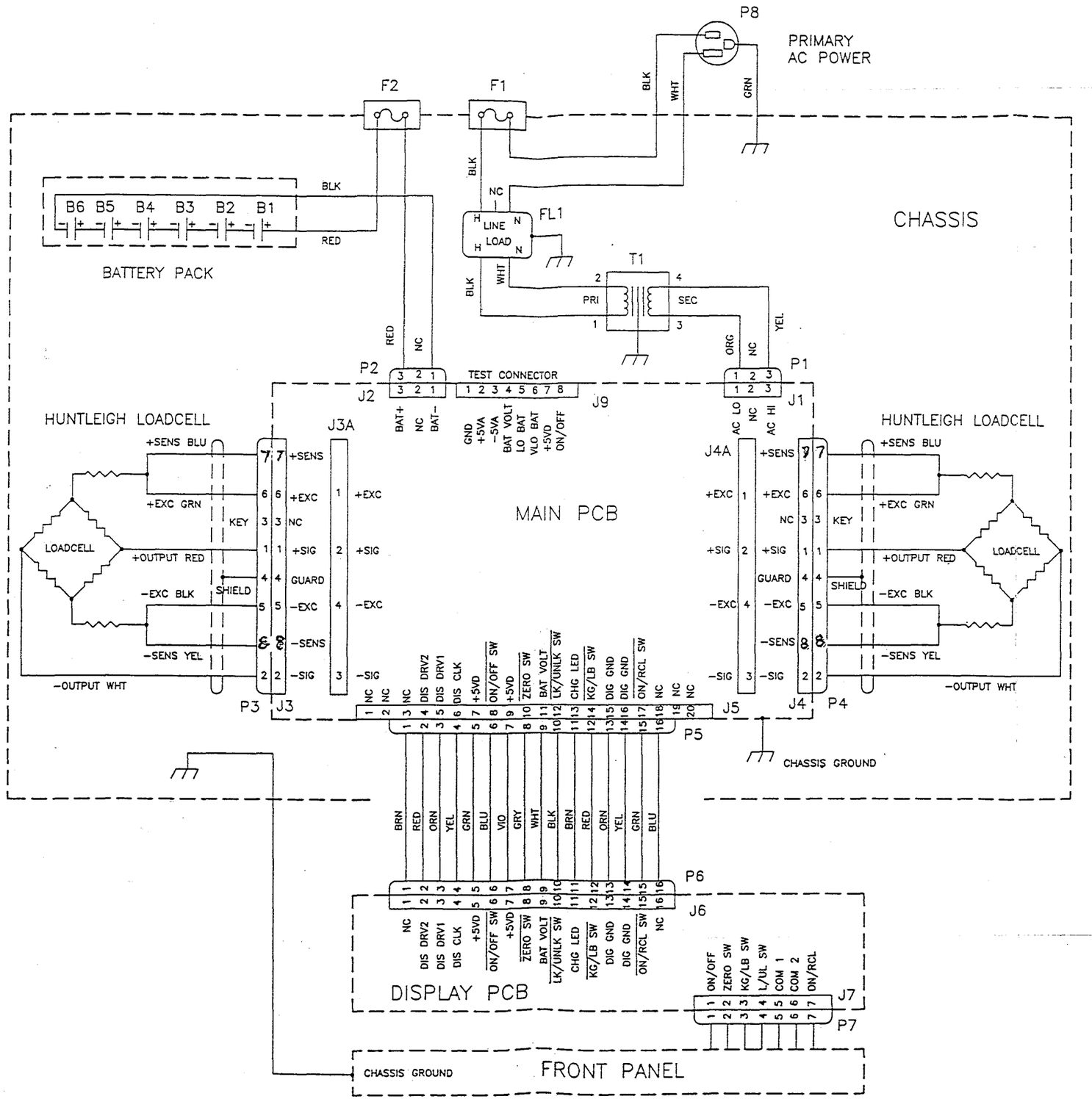


Fig. 4-15

WIRING DIAGRAM
PEDIATRIC SCALE MOD50

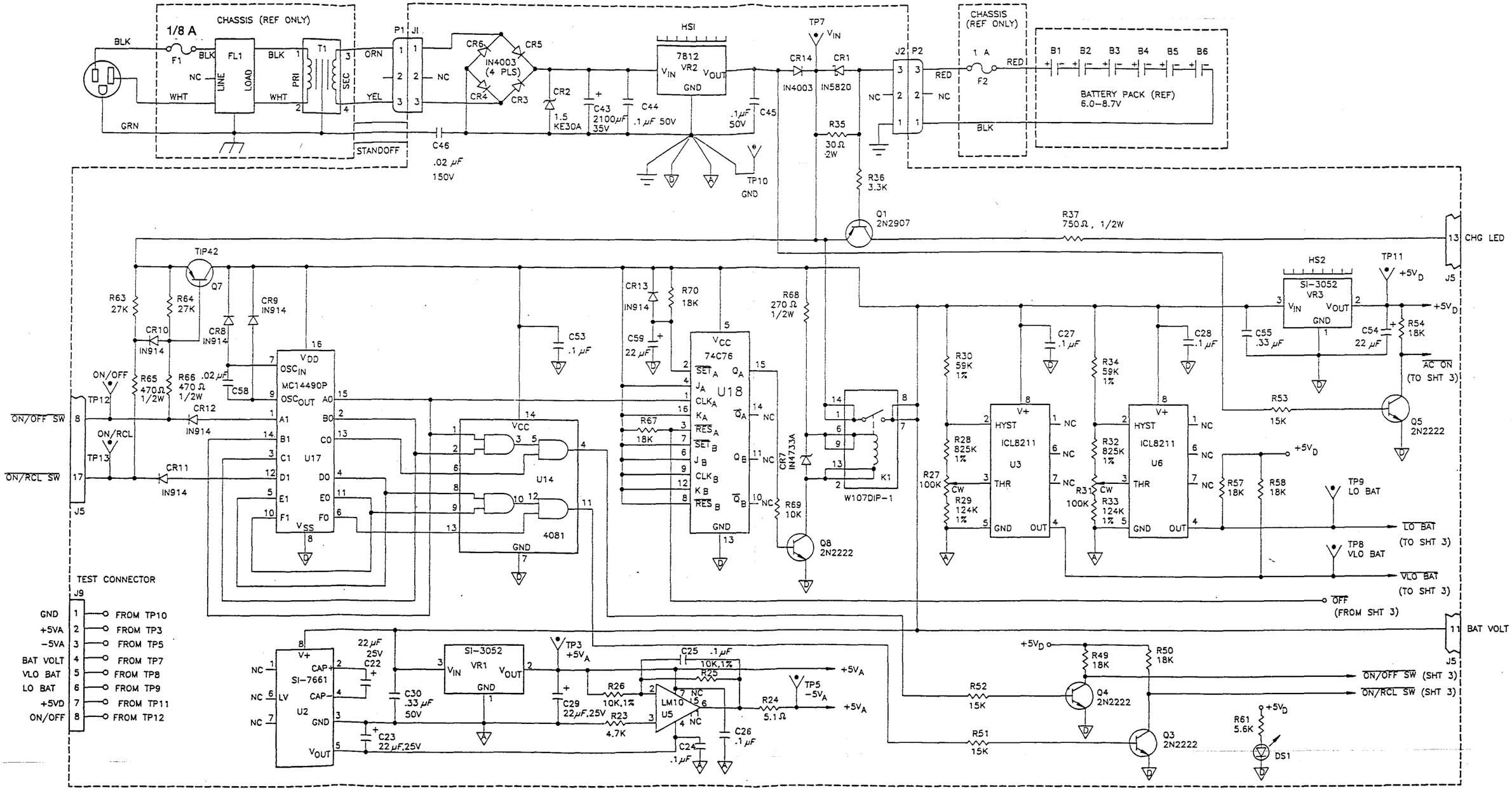


Fig. 4-16

SCHEMATIC, MAIN PCB - SHEET 1 of 3
PEDIATRIC SCALE

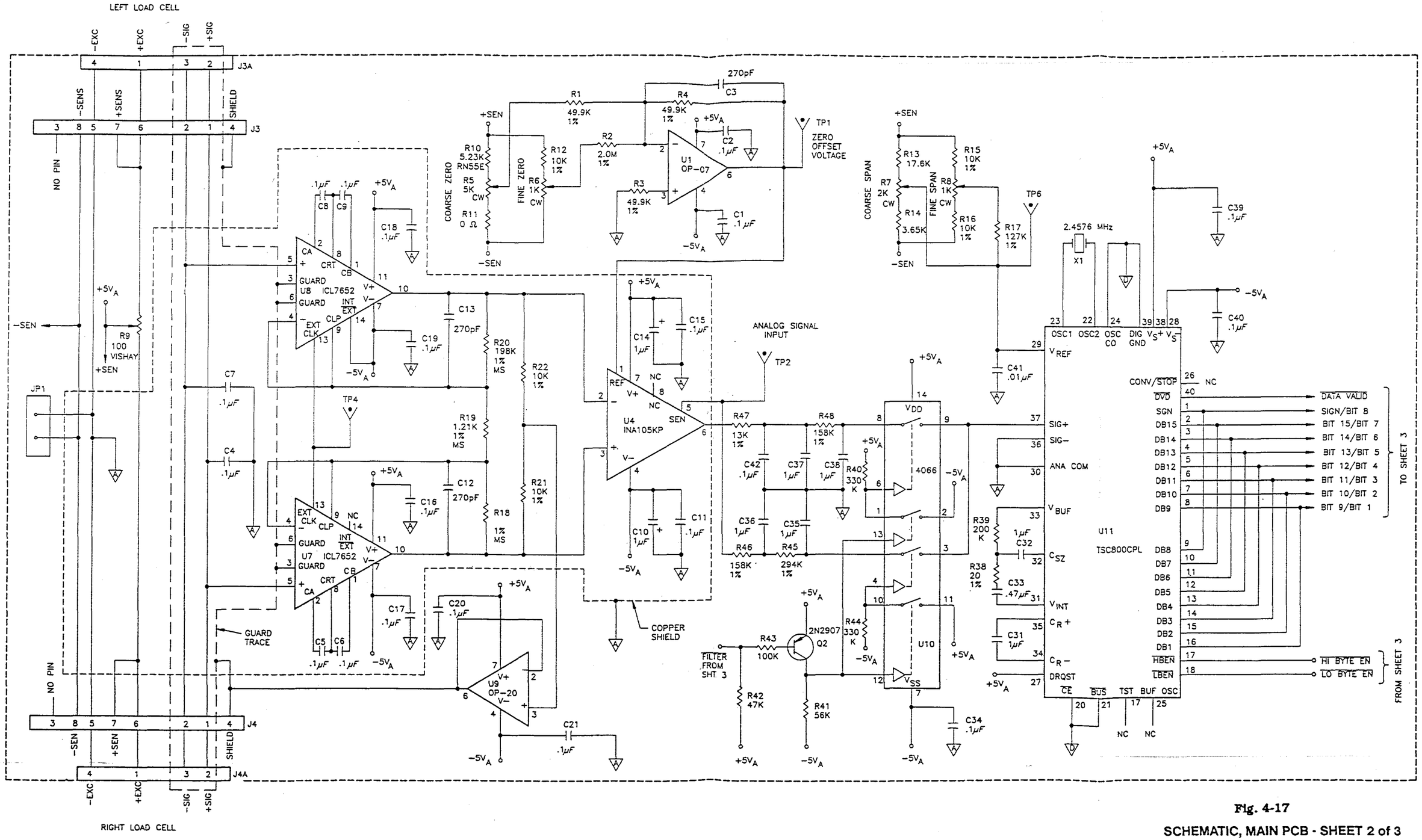


Fig. 4-17

SCHEMATIC, MAIN PCB - SHEET 2 of 3
PEDIATRIC SCALE

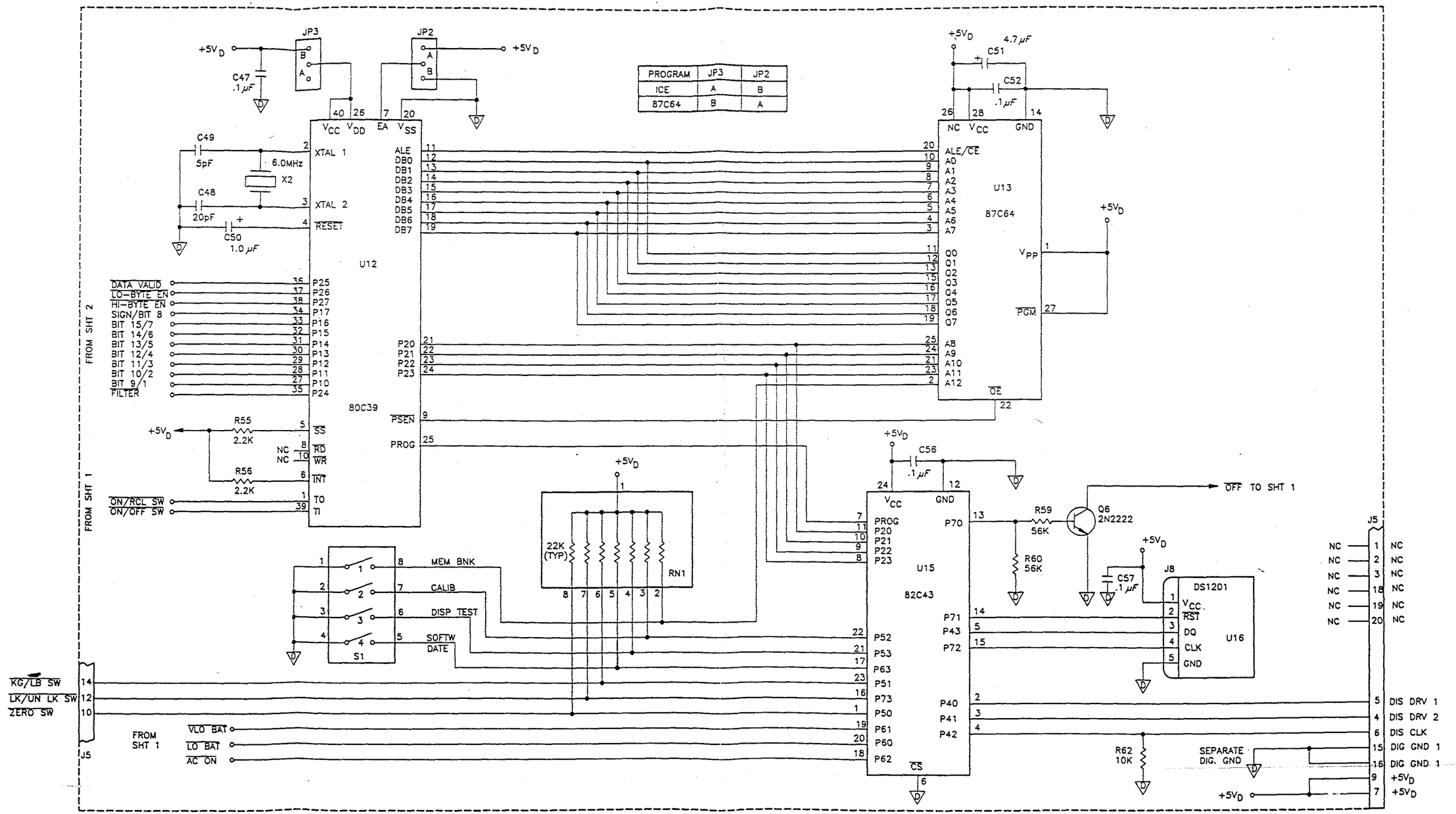


Fig. 4-18

SCHEMATIC, MAIN PCB - SHEET 3 of 3
PEDIATRIC SCALE

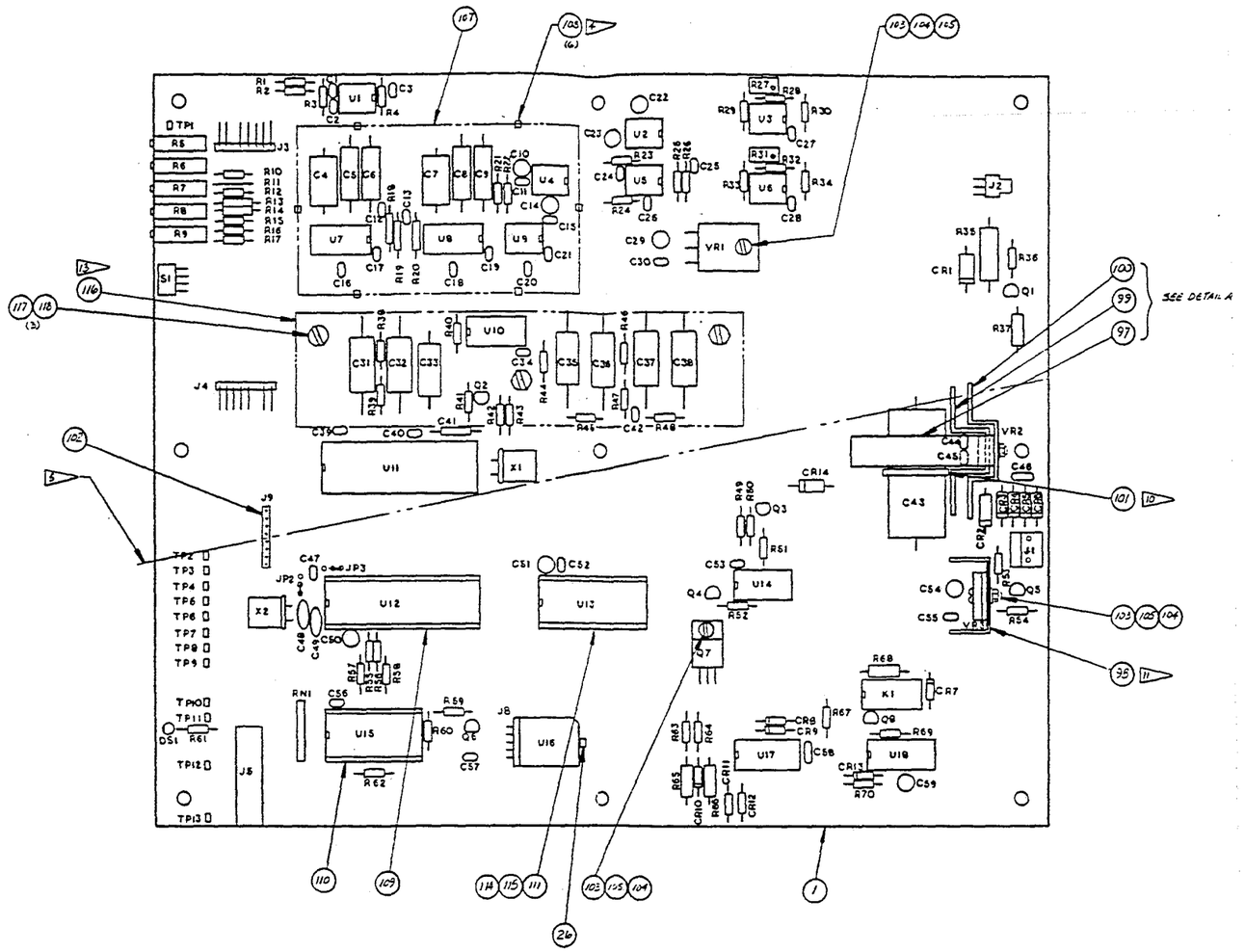


Fig. 4-18

MAIN PCB ASSY

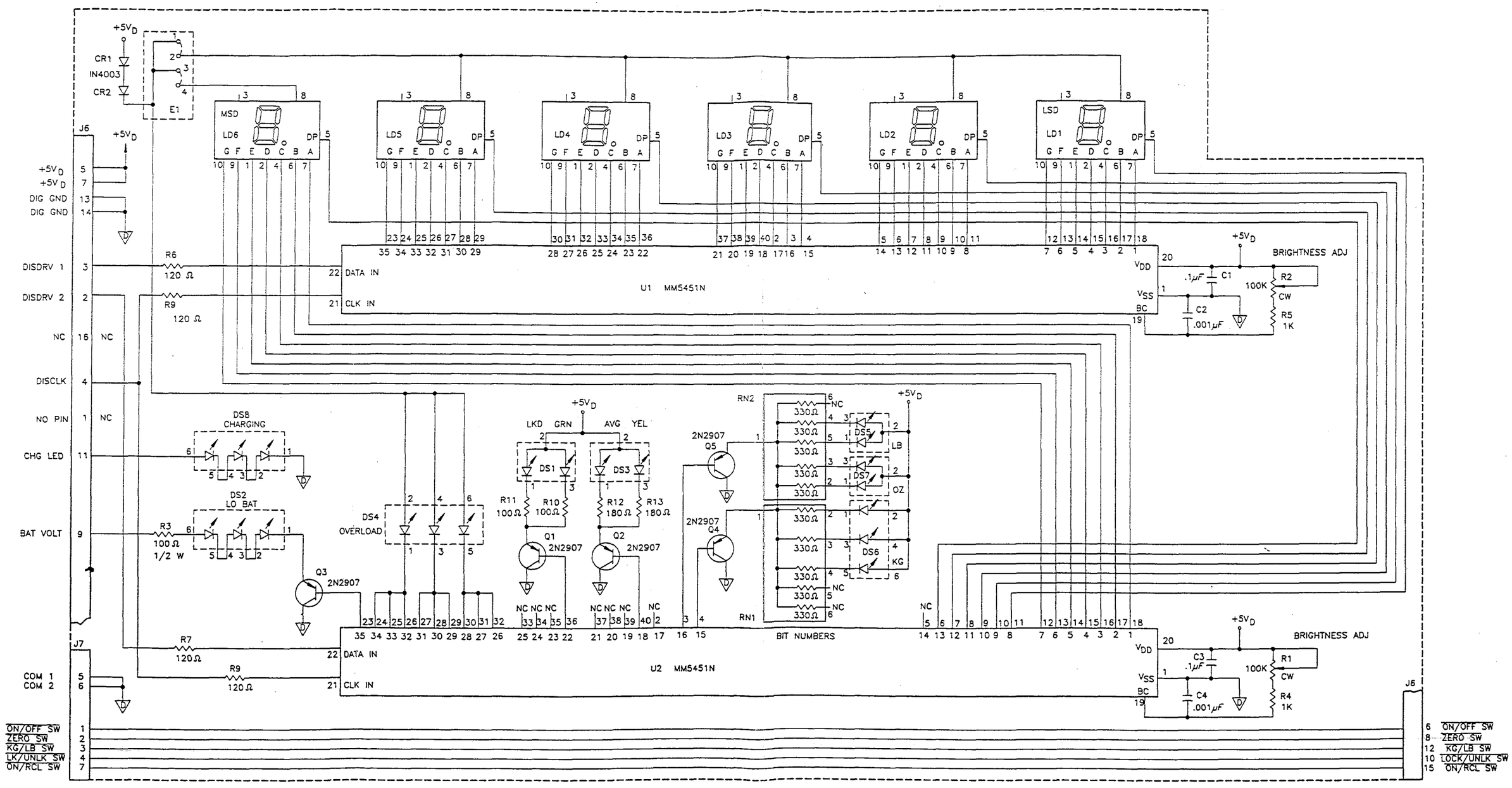


Fig. 4-19

SCHEMATIC, DISPLAY PCB
PEDIATRIC SCALE

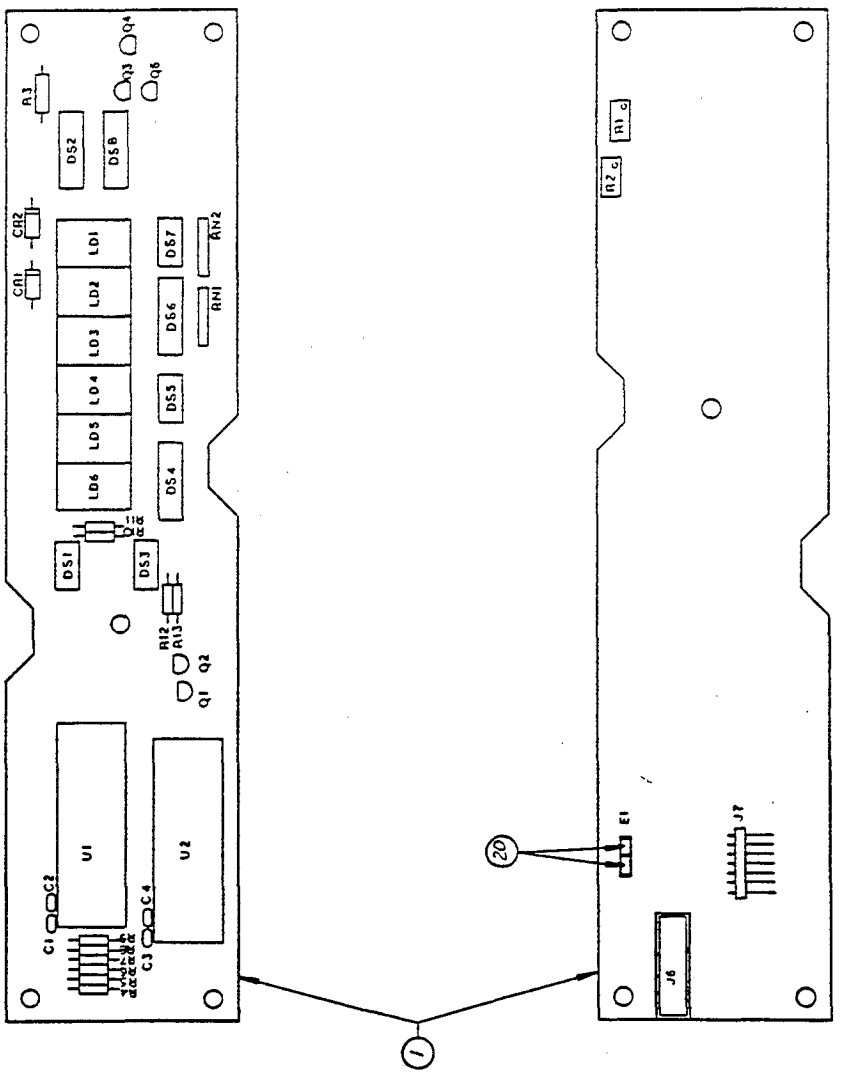


Fig. 4-20
DISPLAY PCB ASSY
PEDIATRIC SCALE